Artificial Intelligence
Prof. Masum
Department of Computer Science and Engineering
Indian Institute of Technology - Delhi

Lecture - 7
Logic in AI: Semantics, Part 3

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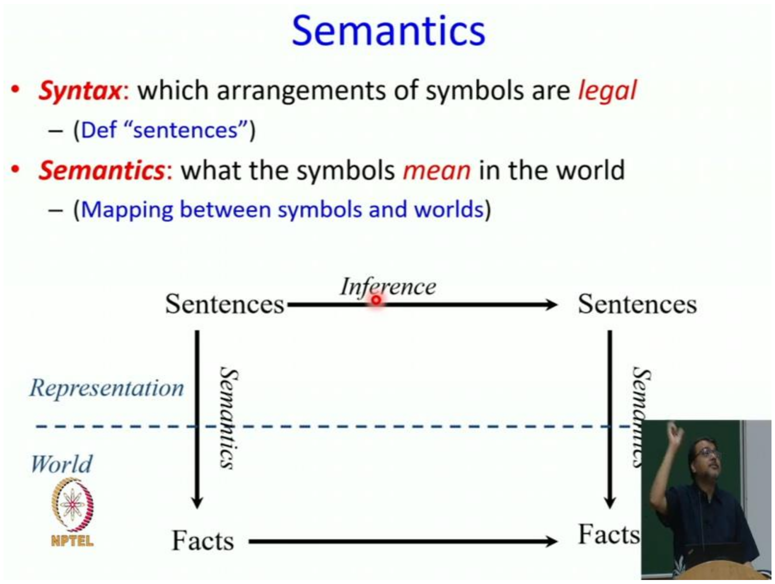

Now comes the semantics part of it. And to understand semantics it is always helpful to think about the real world and the computational representation. Because there is a dash line between the 2 there is a distinction between that 2. The world also has facts. I am not saying the world does not have facts, but the facts in the world are probably much, more fine grained than the facts in the representation as a representation is always an approximation of the world.

For example, Let us say there are 3 people sitting in 2 chairs, they are sharing the chair. Now, how do I represent this in logic? Do I say that you know both Visawjith and the next guy what is the name Ashif sitting in the same chair and Ashif also sitting in a different chair, so, are multiple facts true for Ashif, then it will complicate the assertion that only one person should be sitting in one chair and one person should be sitting in only one chair and so on and so forth.

So, it is going to create hassle. So, in the real physical world, lots of things happen. You are we are talking at some level then we go inside, then there is a subatomic level atomic level you know, angles and joints and continuous values and then we make assertions which are approximations, and then they represent those assertions in the computation language. So, we will have to define a term representation for actual real world physical phenomenon.

And that is called a model also and often it is said all models are wrong, but some models are useful. This is a very beautiful statement, which we will come back to when we talk about Bayesian networks. Anything that you say is going to be wrong in the real world exactly, that does not happen. But some models will be useful in approximating the real world usefully and some models will not.

And here my use of the word model is like the representation of the world and not the model in which we think about logic where these are there are models for the certain assertion, some states are consistent and some models some states are not consistent. So, there are different terms for model meanings of model. So, what is actually happening in that whenever I say P in my computation representation that is equivalent to some real world fact.

That Vishwajith is sitting on chair 25 and all these facts have some appropriate representations here and all sentences by representation have an associated fact in the real world. And as the associated facts in the real world can imply new facts, which I have not explicitly stated in the very same way the inference procedure will imply new sentences in the representation world.

So, we are mimicking the real world is doing something we are making that in the representation world as we make inferences in the representation world there will be real inferences happening in the actual fact of the world and when we go back and forth from the actual physical fact or real world fact to the computational representation that process is called semantics. What is the actual meaning of this sentence in the actual world that we are modeling that is called semantics.

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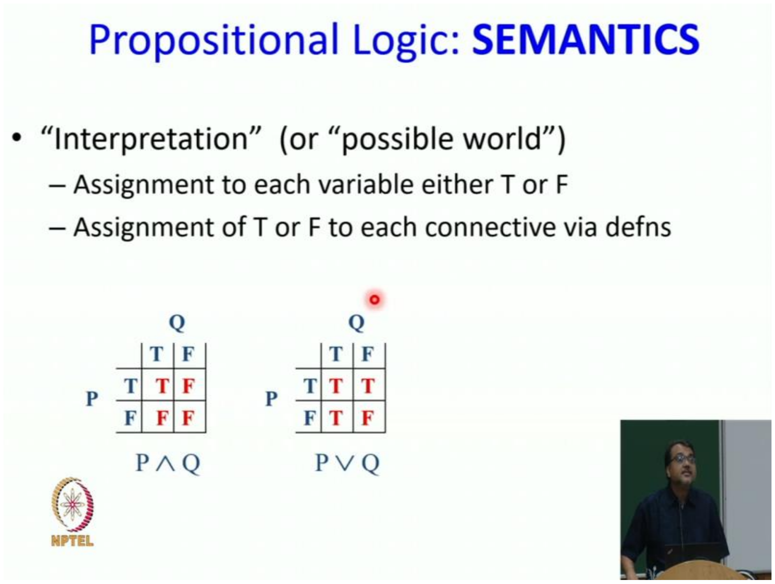

So, a simple example of semantics is the interpretation of the possible worlds. So, for example, if I say P and Q, then only the model consistent with P true and Q true would be consistent with P and Q. Whereas if we say P or Q only the model consistent with P false and Q false will not be consistent with P or Q all other models would be consistent with your Q. So, this is the semantics that when I make an assertion in the competition world, which kinds of facts in the real worlds stick.

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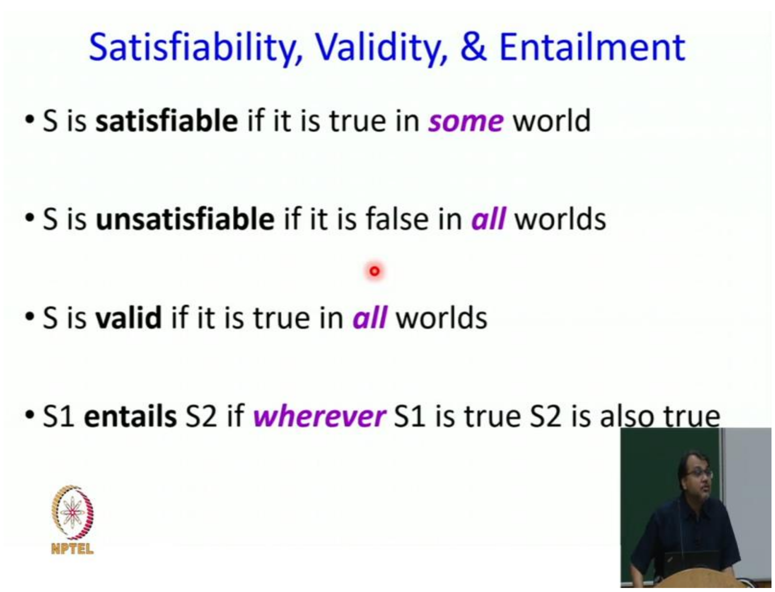

Now, I will define some mortars I have to define a few terms before we can get started. So we have to define these terms called satisfiability unsatisfiability, valid it valid sentence and entailed. For example, S is satisfiable if it is true in some world that means it is a model it has a model S is satisfiable if it is true in some world, there exists some assignment of variables such that S is satisfiable or S is true, S is unsatisfiable if it is false. In all the words there does not exist a single world, which is consistent with S there is no model for S.

S is valid or tautology if it is true in all possible worlds if it is always true if this particular sentence is always true. And then we say that S1 entails S2 if in all the worlds where S1 was true S2 was also true, let us look at some examples.

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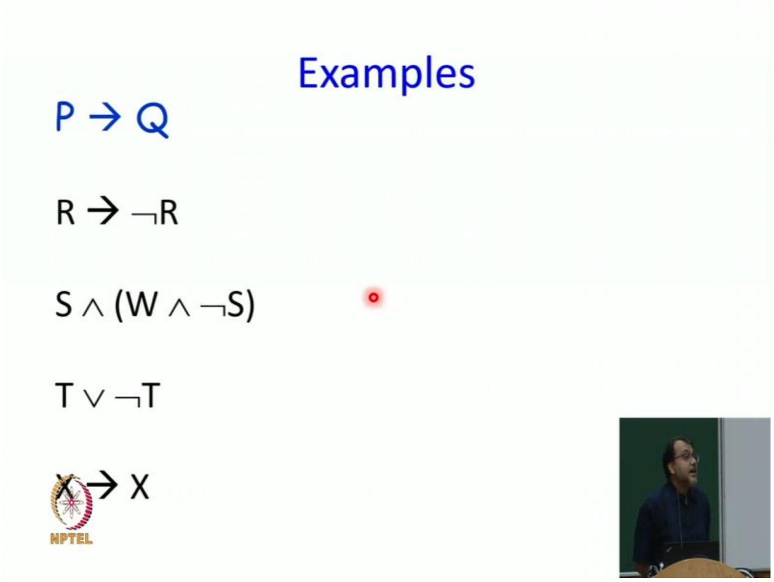

P arrow Q, is it satisfiable unsatisfiable valid or yeah valid P arrow Q is it satisfiable unsatisfiable or tautology satisfied because there is some world where P arrow Q is true. For example P true Q true but there is also some world where P arrow Q is false therefore it is not a tautology. How about R implies not R? This is tricky. Wait do not be too quick. Is it satisfiable unsatisfiable or a tautology? Impressive.

It is satisfiable why? How is it satisfiable? This false if I put R false in you can satisfy this term or implies not for people who did not understand this the implication is a syntactic sugar for not and R, so R implies not R becomes not R or not R, which is satisfiable. How about this S and W and not S? Unsatisfied, this is not satisfiable in any world, right? How about T or not T? It is a tautology because either T is true or T is false.

So, it is a tautology and last X implies X is also tautology. Because if X is false, this is true and if X is true, this is true, how about entails I have given you an example of entails, let us say my sentence 1 is X greater than equal to 5 and my sentence 2 is X greater than equal to 4, does S1 entail S2? My sentence 1 was X greater than equal to 5. My sentence 2 is X greater than equal to 4, does S1 entail S2?

Yes, in every model where X was greater than equal to 5, X is also greater equal to 4. An example in propositional logic P and Q, does P and Q entail P does P and Q entails P? Does P entail P or Q? So, this is entailment and all the words real worlds which are consistent with S1 or they also consistent with S2. Then I will also define a little bit of notation.

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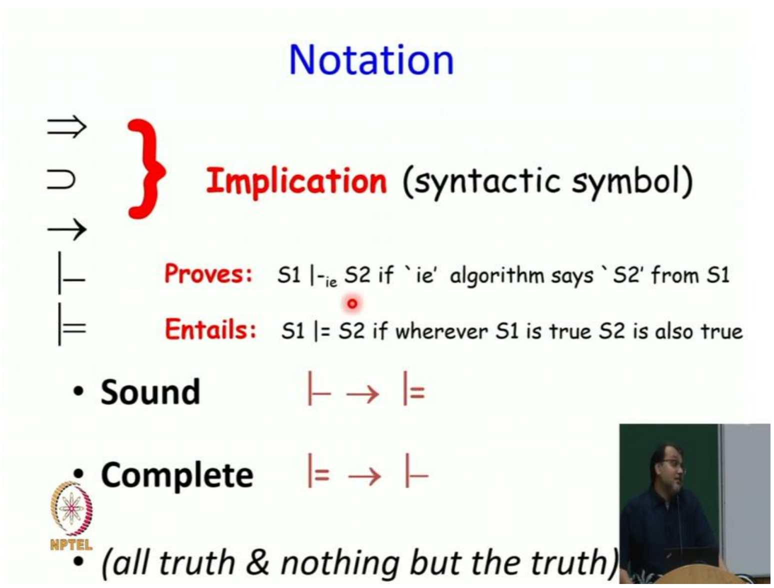

So, these 3 will be the same thing, whether I use double implication, symbol implication or this other symbol for implication, these are equivalent syntactic symbols. However, there are 2 very important symbols that we need to define. One is a symbol for proves and one is the symbol for entails. Now, notice that entails is a phenomenon about logic, whereas proves is a phenomenon about a specific inference procedure.

S1 proves S2 using the present procedure, IE is short for some inference engine, if the algorithm says S2 from S1, if algorithm can prove S2 from S1, where as S1 entails S2 which happens if any word consistent with S1 also S2 true in it. So, one is a property of what is happening in the world in the semantics of logic and one is a property of what I am able to prove it is possible that it is true, but I am not able to prove it.

If that happens, I will call the algorithm not sound or not complete. Whereas, if an algorithm proves something, which is not true, which is actually not entailed then I will call it algorithm not sound. So, a sound algorithm is one which whenever it says something it only says the correct thing. Whenever it says something to be proven, then it is actually entailed in the actual world, whereas an algorithm is considered complete.

If whenever something is entailed it is able to said it is able to prove it. So, sound and computer algorithm will be all truth and nothing but the truth. Complete algorithm will be all truth. And a sound algorithm will be nothing but the truth. So, as an algorithm, which does not open its mouth? Is it a sound algorithm or a complete algorithm? It is a sound algorithm never says something wrong, does not say anything.

And algorithm they said, everything is true. That is a complete algorithm because even the true things are true. But it is never it is not sound algorithm everybody okay with sound and completeness, soundness and completeness. Okay good.